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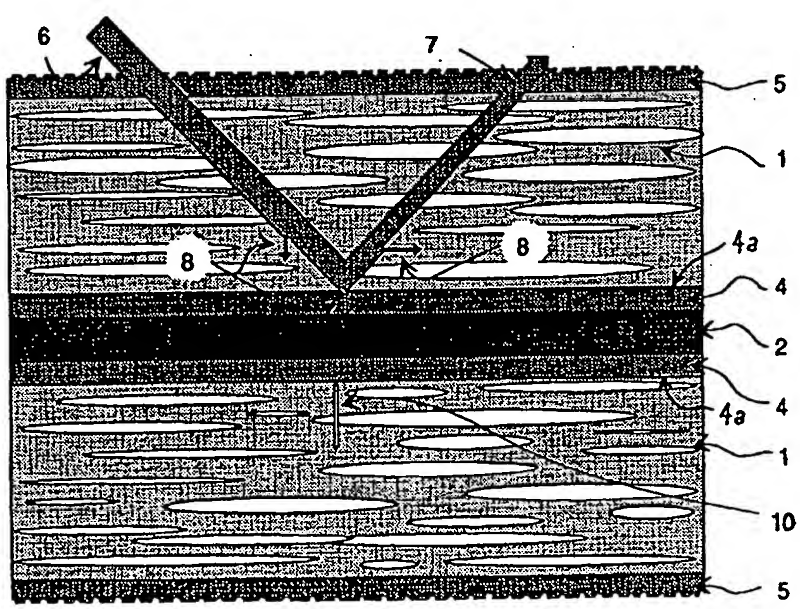
(54) Title: FOOTWEAR SOLE CONSTRUCTION



(57) Abstract

A footwear sole construction has an insulating layer (1) with poor heat conductivity but good permeability to heat radiation, the insulating layer (1) and a reflective layer (4) attached thereto being placed between the inner lining or the like and the wear sole. The reflective surface (4a) of the reflective layer is attached directly to the material of the insulating layer (1), e.g. by attaching a metal foil to the insulating layer (1) by vacuum evaporation.

Footwear sole construction

The present invention relates to a footwear sole construction as presented in the preamble of the accompanying claim 1.

In the soles of the footwear, air-containing porous plastic has been used as heat-insulating material, which plastic has poor thermal conductivity and which therefore serves as an insulator. The construction of the insulator is so dense that the convection, i.e., in this case the air flow through the insulator, is prevented. A material of this type is most commonly of foamed polyurethane, EVA (ethylene-vinylacetate) foam or latex foam. Another generally used solution is to "lighten" the somewhat thick sole construction by shaping projections on the sole surface which is against the foot, between which projections there is left material and weight saving air pocket which, at the same time, is a heat-insulating construction.

Due to the cellular construction of the plastic used, the proportion of the heat radiation in the heat transfer increases, because the heat radiation penetrates easily the gas pore or the air pocket, although conductivity and convection are insignificant. To prevent the heat loss caused by heat radiation, a reflective layer can have been glued on the surface of the insulating layer, which reflective layer is most commonly a thin metal film, e.g. a lustrous aluminium foil. A lustrous metal surface well reflects the heat radiation coming via the insulating layer and it should thus prevent heat loss by radiation.

In prior art solutions, the reflective layer is attached to the insulating layer by gluing. Although the glue layer is thin (0.02—0.03 mm) and e.g. visually seen it is transparent, it can affect the heat-insulating properties. Many materials used as a glue absorb well heat radiation in the wavelength area of 8 to 15 µm, and the quantity that is absorbed can well exceed even 80 %. Also the radiation reflecting back from the reflecting surface of the reflective layer is absorbed when returning to the glue layer, so that over 95 % of the heat radiation can be absorbed even to a thin glue layer. The quantity of the heat radiation returning to the insulating layer can thus be very small. Hence, the problem is that the materials of the reflective layer also conduct well heat, wherein

when the heat is transferred by conducting from the glue layer to the reflective layer, heat is transferred out exactly due to the good heat conductivity of the reflective layer, e.g. to the glue layer on the opposite side of the reflective layer.

These problems are present both in situations in which it is desired to protect the foot in the footwear against cold or against heat surrounding the sole from below. In the former case, the heat should be prevented from transferring out from the interior of the footwear, and in the latter case from outside into the footwear. A metal foil glued to the insulating layer does not operate, i.e., reflect heat radiation, as planned.

British Patent application GB-A-2137866 discloses a separate insole in which a surface which is facing the inner sole is made of polyester coated with a metal film, and between the outermost metal surface and the inner sole there is an additional intermediate layer, having a thickness of 1 mm, attached to the metal surface, perforated and made of polyethylene. The polyester layer (PET) on the side of the foot behaves in the same manner as the glue layer; it conducts well heat, and the openness of the intermediate layer facing the inner sole subjects the metal layer to mechanical damages and the heat is capable of transferring partially by convection through holes, particularly in the case of a separate insole, which will move during the use.

The object of the invention is to eliminate the above mentioned disadvantages and to present a sole construction with improved heat insulation properties, the sole construction being most commonly an insole used between the inner lining and the wear sole. To attain this object the sole construction is mainly characterized in what is presented in the characterizing portion of the accompanying claim 1. The reflective surface of the reflective layer is attached directly to the material of the insulating layer without an intermediate absorbent glue layer. The significance of this construction has until now remained undiscovered, but it can be proved that the advantage achieved by means of it is distinctly to be noticed in connection with insulating layers permeable to heat radiation.

In the following, the invention will be described in more detail with reference to the accompanying drawings, wherein

Fig. 1 illustrates a cross section of a conventional construction and phenomena taking place therein,

Fig. 2 illustrates a cross section of a construction in accordance with the invention and phenomena taking place therein,

Fig. 3 shows how the construction in accordance with the invention is located in the footwear, and

Fig. 4 shows a second alternative of the sole construction.

In Fig. 1 the reference numeral 1 refers generally to an insulating layer having the predominant task of preventing heat transfer from taking place by conduction. The insulating layers employed advantageously in the construction of the invention are discussed later. To this layer there is attached, by using a glue layer 2, a reflective layer 3 made of such material that its surface reflects more than 90 %, preferably more than 95 % of the heat radiation coming thereto in the wave-length area of 8 to 15 µm. Such materials include metals, and the most employed material is aluminium. The reflective layer 3 can be further attached to its other side to another construction by means of a glue layer 2. The above described heat transfer phenomena are further illustrated schematically by arrows, of which an arrow 6 refers to incoming heat radiation, an arrow 7 to reflected heat radiation, arrows 8 to absorbed heat radiation and arrows 9 to heat transfer taking place between the layers by means of conduction.

Fig. 2 illustrates a construction according to the invention, in which, as in Fig. 1, the thickness of the layers has been exaggerated for the sake of clarity. The insulating layer 1 is generally of plastic material with good heat-radiation permeability but poor heat conductivity being characterized in the employed layer thickness by a heat-radiation permeability of 40 to 90 % taken as average in a wavelength area of 8 to 15 µm, particularly in the wavelength range between 9 and 10 µm, which corresponds to foot temperature. Furthermore, a material of this type is

characterized by the fact that, particularly compared to an ordinary polyethylene-terephthalate (polyester) of the same thickness, it is in the employed layer thickness characterized by at least twice, preferably at least three times, higher heat-radiation permeability in the wavelength range of 9 to 10 μm. The material is advantageously of some expanded polyolefin having a cellular construction brought about by orientation. Most advantageously suitable are such films which have a thickness not exceeding 0.1 mm, and most commonly in an area between 0.025 and 0.06 mm and having a closed-cell cellular construction brought about by cavitation technique. One suitable film material is polypropylene, and applicable for this purpose is e.g. a commercial OPP-film, which is known from other contexts. A reflective layer 4 is attached directly on the surface of the insulating layer 1, wherein a reflective surface 4a crucial to the heat-insulation has a direct contact with the material of the insulating layer 1. It is important that the interface is sharp so that the material having the above mentioned properties of the insulating layer 1 changes at the interface layer to the material of the reflective layer 4 without an intermediate layer having distinctly different properties from those of the insulating layer. Non-glue attachment of this kind to the insulating layer can be obtained e.g. by vacuum evaporating the material of the reflective layer 4 onto the surface of the insulating layer 1, and this can be obtained by a known vacuum evaporation technique of metals, by which technique plastic materials are metallized. Also other methods can be considered for attaching the film directly onto the surface of the insulating layer, e.g. a closed cellular construction could be formed directly on top of the metal film.

Due to this construction the heat radiation (arrow 6) is reflected almost entirely (arrow 7) from the reflective surface 4a, because there exists no heat-absorbing material between the insulating layer 1 and the reflective layer 4, and only the portion (arrow 8) determined by the properties of the material of the reflective layer 4 is absorbed and is transferred away by conducting. E.g. the emission coefficient of a vacuum-evaporated aluminium film is 0.04 at temperature of 20°C, which corresponds to a reflectivity of 96 %.

The thickness of the reflective layer 4 is most advantageously not more than 50 nm, which is a relatively thick layer in vacuum-evaporation technique, corresponding to a basis weight of 0.15 g/m^2 for aluminium.

Further, the insulating layer 1 is characterized by the fact that it is a film having a uniform macroscopic construction and covering the reflective layer 4, i.e., it is closed having no holes in the middle through which the heat could pass through the film by convection, the air operating as the medium, and through which the reflective layer would be subject to damages.

The above mentioned layers constitute the minimum conditions for the invention to be functional. Provided that it is desired to maintain heat in the interior of the footwear, the insulating layer 1 is in the insole on the side of the inner lining and the reflective layer 4a faces consequently the inner linings. In case it is desired to protect the foot from hot surroundings, e.g. the footwear being intended for walking on hot grounds, the insulating layer 1 is positioned in the insole on the side of the wear sole and the reflective surface 4a of the reflective layer faces consequently the wear sole. However, Fig. 2 shows at the same time a two-sided construction according to the invention which construction can be used for preventing the heat from transferring from both sides. In this case the construction has a second insulating layer 1 and a reflective layer 4 attached directly thereon, the layers being situated in a mirror symmetrical manner in relation to the first layered construction in a manner that the reflective layers 4 are situated in the middle of the construction and their reflective surfaces 4a reflecting heat radiation are facing to the opposite directions towards their own insulating layers 1. These layered constructions comprising an insulating layer 1 and a reflective layer 4 can be attached together by attaching the reflective layers 4 at their free surfaces together, e.g. by means of an intermediate glue layer 2, which has no disadvantageous effect in this position. Also in case of the two-sided construction only a small proportion of the heat radiation coming through one insulation layer 1 is transferred by conducting away through the reflective layers 4 and the glue layer 2 and is radiated to a second insulating layer (arrow 10). Fig. 2 further shows how the insulating layers 1 are joined at their outer surfaces to the rest of the sole construction 5, e.g. to an ordinary insole material,

and at this point a glue line also can be used for joining. The inner lining can serve as the layer 5 above, and beneath there can be the uppermost blank piece of the insole, having the size of the shoe sole. As for the use and manufacturing, the two-layer construction includes the advantage that the inner thin reflective layers 4 are well protected and the outermost insulating layers 1 function as attachment surfaces with the other layers. Particularly in the insole, but also elsewhere in the shoe sole, the thin layer 4 is not subject to bending to the degree that it would be damaged.

The insulating layer 1 can be used for separating the reflective layer 4a from such layers of the sole construction which have a distinctly poorer heat-radiation permeability than the insulating layer 1 or which are practically non-permeable to heat radiation.

The above-mentioned two-sided protection can also be obtained by means of a construction having the reflective layer 4 attached on both sides of the insulating layer 1 in accordance with the invention, wherein on both sides of the insulating layer there is a reflective surface 4a directly against it, which reflective surface is capable of receiving the heat radiation coming through the insulating layer 1 without intermediate absorbent material. The glue line is also in this situation elsewhere than between the reflecting surface and the insulating layer. On the other hand, the heat radiation in this construction is low as such, because the reflective layer 4 has a poor emissivity and it does not radiate much when warmed up.

Fig. 3 shows a cross section of a footwear in which the sole construction is situated. The construction is most advantageously a layered construction situated close to the interior of the footwear, in the example of Fig. 3 a fixed insole 11, to which the vamp or upper 12 is attached by using methods generally known in footwear industry. An outsole to which the ready-made vamp part is connected by means of a soling method is denoted by reference numeral 13, and the filling which is left between the insole 11 and the outsole 13 is denoted by reference numeral 14. The entity constituted of one or several insulating layers 1 and reflective layers 4 is placed to a correct position in relation to the

direction of the incoming heat radiation, preferably in the middle of the insole, wherein they are supported and protected by its layers.

Fig. 4 shows yet another sole construction, i.e., a separate insole 15 or insert positioned on top of the inner sole (interior bottom) of the footwear. Also here the layered construction composed of the insulating layer 1 and the reflective layer 2, most advantageously the two-sided construction of Fig. 2, is situated preferably in the middle, wherein on its other side there is a layer having the suitable properties and placed against the foot sole, and on the other side there is a layer placed against the inner sole.

The invention is further illustrated with the following two Examples, which are not to restrict the scope of protection.

Example 1.

The effect of the glue layer on heat reflection was measured by means of a long-wave camera. The test included three samples, the order of the samples from the top to the bottom being:

Sample 1: OPP-film — vacuum-evaporated aluminium layer — glue layer — OPP-film.

Sample 2: OPP-film — glue layer — vacuum-evaporated aluminium layer — OPP-film.

Sample 3: OPP-film — glue layer — OPP-film.

The OPP-film is a biaxially oriented polypropylene film. The samples were placed side by side on a surface of room temperature (23°C). On the other side of the samples a vessel of warm water (36°C) was placed to serve as the heat source and on the other side a heat camera was placed by which the temperatures of the heat source and the sample surfaces were measured. The surface of the sample 1 showed a temperature of 27°C and the surfaces of the samples 2 and 3 both showed a temperature of 25°C and the surface below showed a temperature of 23°C. According to the measurement, the glue layer

between the OPP-film and the aluminium surface prevented the heat-reflecting effect of the aluminium and the reflectivity showed the same value as the sample without the aluminium layer.

Example 2.

Various insoles were manufactured for tests. The basic materials were common commercial insole materials. An element according to the invention was laminated to a part of the samples. The warmth of the different solutions were measured by employing a device in which the sample to be measured was pressed against an aluminium surface in a cold weather room (—10°C) by means of a heating element constructed for this purpose. The heating element was heated at a constant power and the temperature was measured on the surface of the sample after the stabilization time of two hours. The better the insulation was, the higher the temperature that was measured. In the test, the insole provided with the element of the invention was 2°C warmer than a corresponding construction without the element (8.9°C versus 10.8°C). When a construction corresponding to the element and having the same thickness but having no reflective layer was laminated to a corresponding insole construction, the insulation properties were improved but distinctively less than when the construction was provided with a reflective layer.

Claims

1. A footwear sole construction having an insulating layer (1) with poor heat conductivity but good permeability to heat radiation, the insulating layer (1) and a reflective layer (4) attached thereto being placed between the inner lining or the like and the wear sole, **characterized** in that the reflective surface (4a) of the reflective layer is attached directly to the material of the insulating layer (1).

2. A sole construction as set forth in claim 1, **characterized** in that it has two reflective surfaces (4a) attached to the material of the insulating layer (1) for heat radiation incoming from the opposite directions through the insulating layer (1).

3. A sole construction as set forth in claim 2, **characterized** in that the reflective layers (4) are attached against each other, wherein the insulating layers (1) directly attached to them are outermost and serve as attaching surfaces to the rest of the construction.

4. A sole construction as set forth in claim 1, 2 or 3, **characterized** in that the reflective layer (4) is a metal foil attached to the insulating layer (1) by vacuum evaporation.

5. A sole construction as set forth in any of claims 1 to 4, **characterized** in that it is a fixed insole (11).

6. A sole construction as set forth in any of claims 1 to 4, **characterized** in that it is a separate insole (15).

7. A sole construction as set forth in any of claims 1 to 6, **characterized** in that the insulating layer (1) is a uniform plastic film having a thickness not exceeding 0.1 mm.

8. A sole construction as set forth in claim 7, **characterized** in that the insulating layer (1) is an oriented closed-cell cellular film.

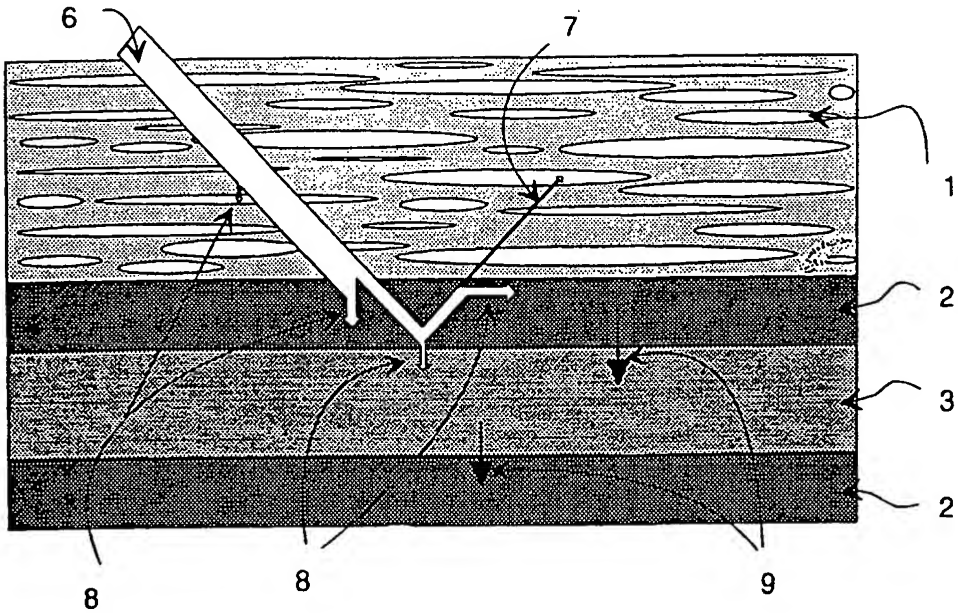


Fig. 1

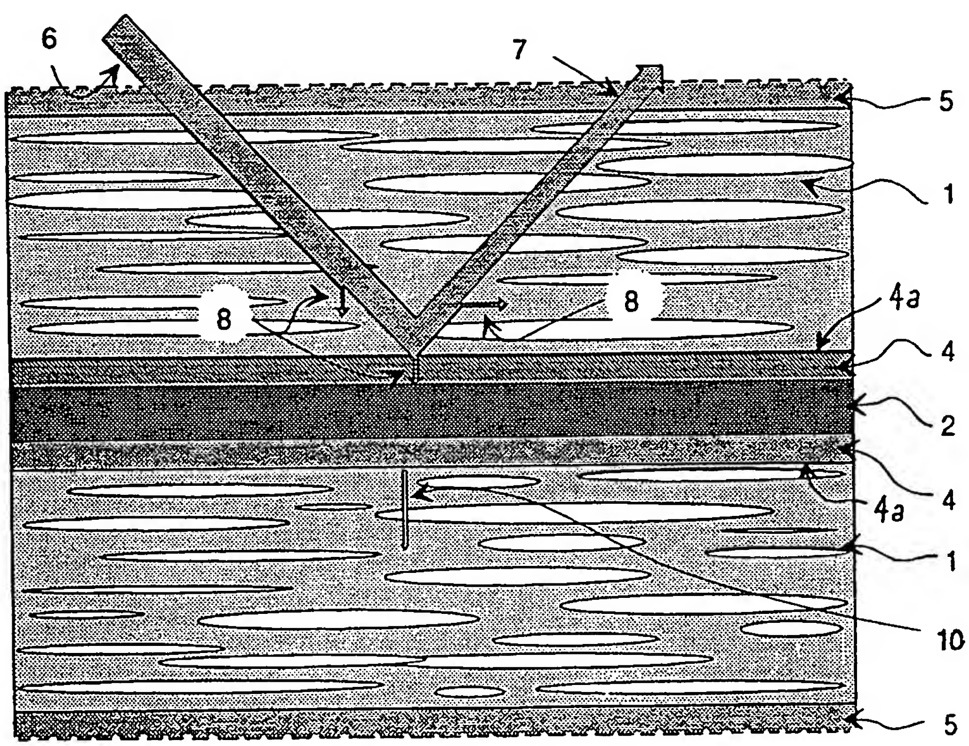


Fig. 2

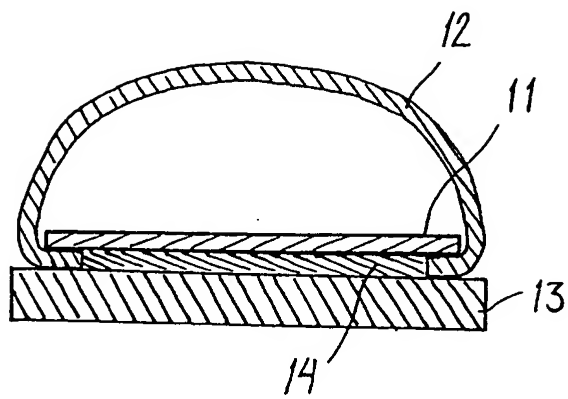


Fig. 3

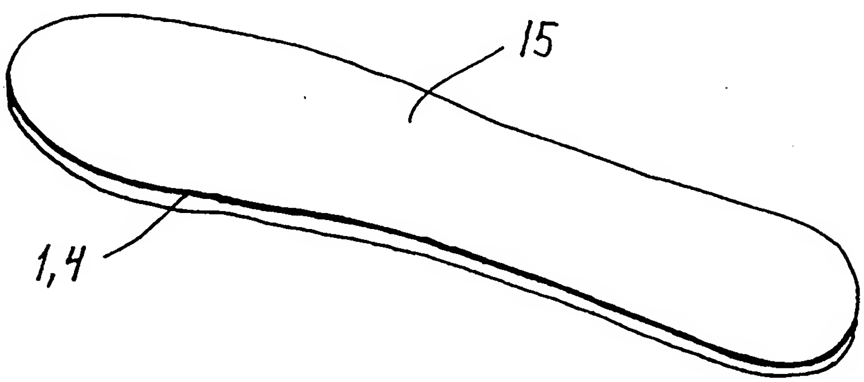


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 96/00394

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: A43B 17/14 // A43B 13/38, A43B 7/34
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: A43B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, CLAIMS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	US 4658515 A (D.S. OATMAN), 21 April 1987 (21.04.87), column 3, line 13 - line 27, figure 4, pos. 50	1,4-8
A		2,3
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
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Date of the actual completion of the international search	Date of mailing of the international search report
1 October 1996	03 -10- 1996
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Sune Söderling Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 96/00394

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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INTERNATIONAL SEARCH REPORT
Information on patent family members

05/09/96

International application No.
PCT/FI 96/00394

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